University of Saskatc
College of Enginee

EE 342: Power Systems I
Midterm Examination
A one formula sheet is allowed

Instructor: S.O. Faried **October 29, 2003**
Duration: 75 minutes

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1. Each of a proposed three-phase 1200-kV, 600 kilometers transmission line consists of a conductor bundle composed of 12 solid conductors symmetrically spaced around a circle 100 cm in diameter. Each conductor has a diameter of 1.2 cm. Each phase bundle is placed in a corner of an equilateral triangle of 15 m side.
   (a) Compute the inductance and capacitance per phase and meter of the line.
   (b) If the resistance of each conductor in the bundle is 0.461 Ohms per kilometer, find the ABCD constants of the line.
   (c) If the load on this line is 6500 MW at 1200 kV and 0.8 power factor lagging, find the line efficiency.
   (d) Determine the wavelength and velocity of propagation of the line.
   (e) Find the MVAR generation per kilometer.

2. Draw the one line reactance diagram for the power system shown in Fig. 1. Select 1000 MVA base and 20 kV base at Generator 3.

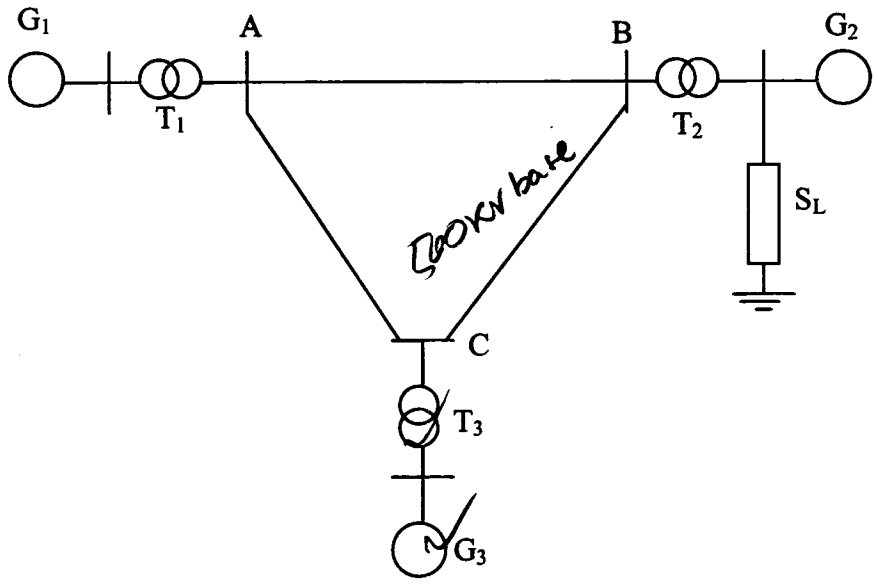
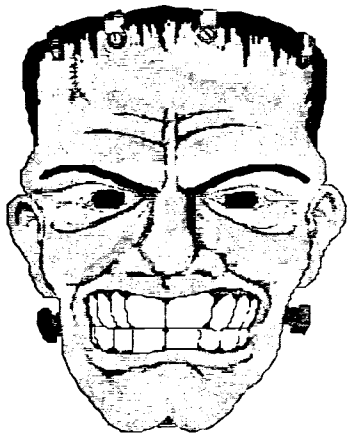


Fig. 1

G_1, 400 *MVA*, 26 *kV*, $x = 0.8$ *p.u.*
G_2, 600 *MVA*, 13 *kV*, $x = 0.8$ *p.u.*
~~G_3, 500 *MVA*, 18 *kV*, $x = 1.0$ *p.u.*~~
T_1, 400 *MVA*, 26/500 *kV*, $x = 0.1$ *p.u.*
T_2, 700 *MVA*, 13/500 *kV*, $x = 0.1$ *p.u.*
T_3, 600 *MVA*, 18/500 *kV*, $x = 0.1$ *p.u.*
$T.L_{AB}$, $x = j50\ \Omega$
$T.L_{BC}$, $x = j40\ \Omega$
$T.L_{AC}$, $x = j60\ \Omega$
S_L, $0.05 + j0.2\ \Omega$



EE 3412

Ken's Midterm Solns

PROBLEMS / 1

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$D_{12} = 0.5176\ R$

$D_{13} = F$

$D_{14} = \sqrt{2}\ R$

$D_{15} = \sqrt{3}\ R$

$D_{16} = 1.3319\ F$

$D_{17} = 2F$

$D_{18} = 1.9319\ F$

$D_{19} = \sqrt{3}\ F$

$D_{110} = \sqrt{2}\ R$

$D_{111} = R$

$D_{112} = 0.5176\ F$

$$L = 2 * 10^{-7} \ln \frac{D_{eq}}{D_s} \quad H/m$$

$D_{eq} = 15\ m$

$$D_s = \sqrt[12]{r' * 0.5176\,R * R * \sqrt{2}R * \sqrt{3}R * 1.9319\,R * 2R * 1.9319\,R * \sqrt{3}R * \sqrt{2}R * R * R * 0.5176\,R}$$

$$D_s = \sqrt[12]{11.9988 * r' * R^{11}}$$

$$D_s = \sqrt[12]{11.9988 * e^{-0.25} * 0.006 * (0.5)^{11}}$$

$D_s = 0.4167\ m$

$$L = 2 * 10^{-7} \ln \frac{15}{0.4167} \quad H/m$$

$L = 7.1671 * 10^{-7}\ H/m$

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$$Z_c = \sqrt{\frac{Z}{Y}} = 215.364 \angle -4.0461^\circ \ \Omega$$

$$\gamma = \sqrt{ZY} = 0.7603 \angle 85.9539^\circ$$

$$\gamma = \alpha + j\beta = 0.0536 + j\,0.7584$$

$$\lambda = \frac{2\pi}{\beta} = \frac{2\pi}{(0.7584/600000)}$$

$$\lambda = 4970.8745 \text{ Km}$$

$$v = \lambda f = 298252.4671 \text{ Km/sec}$$

$$\cosh\gamma = 0.7279 \angle 2.9068$$

$$\sinh\gamma = 0.6893 \angle 86.7623 \quad , B = Z_c \sinh\gamma$$

$$A = D = 0.7279 \angle 2.9068^\circ$$

$$B = 148.5796 \angle 82.7162^\circ \ \Omega$$

$$C = 0.003203 \angle 90.8084 \ \mho$$

$P_R = 6500$ MW , 0.8 P.f. lg

$$P_R = \sqrt{3}\, V_R I_R \cos\phi$$

$$I_R = \frac{6500 * 10^6}{\sqrt{3} * 1200 * 10^3 * 0.8} = 3909.1424 \angle -36.8699^\circ \text{ A}$$

PROBLEM

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$V_S = A V_R + B I_R$

$V_{sph} = 0.7279 \angle 2.9068^\circ * \frac{120000}{\sqrt{3}} \angle 0^\circ$

$+ 148.5795 \angle 82.7162^\circ * 3909.1424 \angle -36.8699^\circ$

$V_{sph} = 1010.2153 \angle 25.9651^\circ$ KV

$V_S = 1749.744 \angle 25.9651^\circ$ KV

$I_S = C V_R + D I_R$

$I_S = 0.003203 \angle 90.8084 * \frac{120000}{\sqrt{3}} \angle 0^\circ$

$+ 0.7279 \angle 2.9068^\circ * 3909.1424 \angle -36.8699^\circ$

$I_S = 2412.2279 \angle 15.1207$ A

$P_S = \sqrt{3} * 1749.744 * 1000 * 2412.2279 \cos[25.9651 - 15.120$

$P_S = 7180.053$ MW

$\eta = \frac{P_R}{P_S} = 90.5286\ \%$